FREE DOWNLOAD

EMERGENCY MANUAL

Cognitive Aids for Perioperative Crises - V4.3 2021
Stanford Anesthesia Cognitive Aid Program

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SHOUT
SHARE
IT

Asystole / PEA

No pulse AND non-shockable rhythm on ECG
e.g. asystole **or any non-VFIB/VTACH**

TREATMENT

Task	Actions
Crisis Resources	• Inform team • Identify leader • Call a code • Call for code cart • Assign team member to read cognitive aid out loud
CPR	• Rate 100 - 120 compressions/min, minimize breaks • Depth ≥ 5 cm; allow chest recoil; consider backboard • **Keep $EtCO_2$ > 10 mmHg and diastolic BP > 20 mmHg** • Rotate compressors with rhythm check every 2 min. Place defibrillator pads. **If becomes shockable VF/VT:** defibrillate 200 J biphasic or 360 J monophasic **See VFIB/VTACH #4** • Check pulse ONLY if signs of ROSC (sustained increased $EtCO_2$, spontaneous arterial waveform, rhythm change) • Prone CPR at lower edge of scapula OK if airway secured • Place defibrillator pads and check rhythm every 2 min
Airway	• **100% O_2 10 - 15 L/min** • If mask ventilation: ratio 30 compressions to 2 breaths • If airway secured: 10 breaths/min, tidal volume 6 -7 mL/kg
IV Access	• Ensure functional IV or IO access
Meds	• **Turn off volatile anesthetic and vasodilating drips** • **Epinephrine 1 mg IV push every 3 - 5 minutes** • If hyperkalemia: calcium chloride 1 g IV; sodium bicarbonate 1 amp IV (50 mEq); regular insulin 5 - 10 units IV with dextrose/D50 1 amp IV (25 g) • If acidosis: sodium bicarbonate 1 amp IV (50 mEq) • If hypocalcemia: calcium chloride 1 g IV • If hypoglycemia: dextrose/D50 1 amp IV (25 g)
ECMO/CPB	• Consider ECMO or cardiopulmonary bypass
Post Arrest	• If ROSC: arrange ICU care and consider cooling
Causes	• Explore H's and T's on next page

GO TO NEXT PAGE »

Page 2 Asystole / PEA

DIFFERENTIAL DIAGNOSIS

TEE / TTE and labs will aid diagnosis; Invite input from team

Heart Rate - Vagal Stimulus
- Desufflate abdomen
- Remove surgical retractors and sponges
- Remove pressure from eyes, neck, ears, and brain. Drain bladder

Hypovolemia
- Give rapid IV fluid bolus
- Check Hgb
- If anemia or hemorrhage:
  See Hemorrhage #12
- Consider relative hypovolemia:
  - If auto-PEEP: disconnect circuit
  - IVC compression
  - Obstructive or distributive shock

  See Anaphylaxis #5

  See High Spinal #14

Hypoxemia
- O_2 100% 10 - 15 L/min
- Check breathing circuit connections
- Confirm ETT placement with CO_2
- Check breath sounds
- Suction ET tube
- Consider chest x-ray; bronchoscopy

  See Hypoxemia #17

Hydrogen Ions - Acidosis
- Consider bicarbonate
- Balance increasing ventilation with potential decrease in CPR quality

Hyperkalemia
- Calcium chloride 1g IV
- Bicarbonate 1 amp IV (50 mEq)
- Insulin 5 - 10 units IV with D50 1 amp IV (25g) and monitor glucose
- Consider emergent dialysis

Hypokalemia
- Controlled potassium infusion
- Magnesium sulfate 1 - 2 g IV

Hypoglycemia
- Dextrose/D50 1 amp (25 g)
- Monitor glucose

Hypocalcemia
- Calcium chloride 1 g IV

Hyperthermia
See Malignant Hyperthermia #19

Hypothermia
- Actively warm: forced air, warm IV fluid, warm room
- Consider ECMO or bypass

Toxins
- Consider anesthetic overdose
- Consider medication error
- Turn off volatile anesthetic and vasodilating drips
- If local anesthetic has been given:

  See Local Anesthetic Toxicity #18

Tamponade - Cardiac
- Consider TEE / TTE
- Perform pericardiocentesis

Tension - Pneumothorax
- Check for asymmetric breath sounds, distended neck veins, deviated trachea
- Consider ultrasound for normal lung sliding, abnormal lung point
- Consider chest x-ray, but do NOT delay treatment
- Perform empiric needle decompression in 4th or 5th intercostal space anterior to the mid-axillary line, then chest tube

See Pneumothorax #22

Thrombosis - Coronary
- Consider TEE / TTE to evaluate ventricular wall motion
- Consider emergent coronary revascularization

See Myocardial Ischemia #20

Thrombosis - Pulmonary
- Consider TEE / TTE to evaluate right ventricular function and RVSP
- Consider fibrinolytic agents or pulmonary thrombectomy

See Embolism #9

See Right Heart Failure #24

END

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Bradycardia

Pulse present, heart rate < 50 bpm, and inadequate perfusion

TREATMENT

Task	Actions
Crisis Resources	• Inform team • Identify leader • Call a code • Call for code cart
Pulse Check	• **If no pulse: start CPR and** **See Asystole/PEA #1**
Airway	• **100% O_2 10 - 15 L/min** • Confirm adequate ventilation and oxygenation
Stop Vagal Stimuli	• Desufflate abdomen • Remove pressure from eyes, neck, ears, and brain • Remove retractors, surgical sponges, and packing • Drain bladder
IV Access	• Ensure functional IV or IO access
Meds	• Consider decreasing anesthetics or analgesics • **Atropine** 0.5 - 1 mg IV every 3 min. May repeat, max 3 mg • If atropine ineffective: epinephrine 5 - 10 mcg IV • Consider dopamine infusion of 5 - 20 mcg/kg/min • Consider epinephrine infusion of 0.02 - 0.3 mcg/kg/min • If stable: consider glycopyrrolate 0.2 - 0.4 mg IV

Pacing	• Place defibrillator pads
	• Consider **temporary transcutaneous, transvenous, or esophageal pacing**
	  • Set pacer rate to at least 80 bpm
	  • Increase current (mA) until electrical capture. Confirm mechanical capture with patient pulse. Set pacer output 10 mA above mechanical capture
	• Consult ICU and/or Cardiology

Arterial Line	• Consider arterial line placement
Labs	• Send ABG, Hgb, electrolytes, troponin
Ischemia Workup	• Obtain 12-lead ECG • Consider checking BNP and serial troponins

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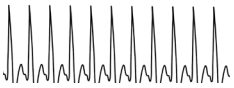
SVT - Unstable and Stable

Non-compensatory tachycardia and Pulse present
Often rate >150 or sudden onset



TREATMENT

Task	Actions
Crisis Resources	• Inform team • Identify leader • Call a code • Call for code cart
Pulse Check	• **If no pulse: start CPR and** **See Asystole/PEA #1**
Airway	• **100% O_2 10 - 15 L/min** • Confirm adequate ventilation and oxygenation
Defib Pads	• Place defibrillator pads for possible cardioversion

Determine if UNSTABLE	• **Unstable if ANY of the following:**
	  • SBP < 75 mmHg
	  • Sudden SBP decrease below patient's baseline
	  • Acute ischemia or chest pain
	  • Acute congestive heart failure
	  • Acutely altered mental status
	• If stable: go to next page
	• **If unstable: continue below**

UNSTABLE SVT:

Immediate Synchronized Cardioversion	• If patient not anesthetized: consider sedation
	• Cardiovert with settings depending on QRS complex (narrow or wide) and rhythm (regular or irregular)
	  • Narrow complex and regular: **Sync 50 - 100 J biphasic**
	  • Narrow complex and irregular: **Sync 120 - 200 J biphasic**
	  • Wide complex and regular: **Sync 100 J biphasic**
	  • Wide complex and irregular: **Unsync 200 J biphasic**

Refractory SVT	• If still unstable:
	  • Repeat synchronized shock with increased joules
	  • Consider amiodarone 150 mg IV over 10 min

STABLE SVT ON NEXT PAGE »

SVT - Unstable and Stable

TREATMENT

STABLE SVT:

Vagal Maneuvers
- Consider vagal maneuver before medications

Determine SVT Type
- Identify complex: narrow or wide
- Identify rhythm: regular or irregular
- Treat based on SVT type using medication doses provided below

Narrow and regular	Wide and regular
• Adenosine • If not converted: rate control with beta blocker or calcium channel blocker	• If SVT with aberrancy: adenosine • If VT or uncertain VT: give amiodarone. May add procainamide or sotalol
Narrow and irregular	**Wide and irregular**
• Rate control with beta blocker or calcium channel blocker • Consider amiodarone	• This is likely polymorphic VT • Consider magnesium for torsades • Consult Cardiology STAT

Meds
- **Adenosine*** push 6 mg IV, flush, and watch monitor to identify SVT type (watch for asystole). May follow with 12 mg IV
- **Beta blocker:**
  Esmolol* 0.5 mg/kg IV over 1 minute. May repeat after 1 minute. Then infusion of 50 - 300 mcg/kg/min.
  Metoprolol* 1 - 2.5 mg IV push. May repeat or double after 3 - 5 minutes
- **Calcium channel blocker:**
  Diltiazem* 10 - 20 mg IV over 2 minutes. May repeat after 5 minutes. Then infusion of 5 - 10 mg/hr
- **Amiodarone** 150 mg IV **SLOWLY** over 10 minutes to avoid cardiovascular collapse. May repeat once. Then infusion of 1 mg/min
- **Procainamide*** 20 - 50 mg/min IV (max 17 mg/kg) until arrhythmia suppressed. Then infusion of 1 - 4 mg/min
- **Sotalol*** 100 mg IV over 5 min

***Use with caution if asthma, avoid if WPW/CHF*

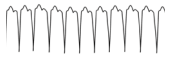
ECG
- Obtain 12-lead ECG or print rhythm strip

Labs
- Consider arterial line placement, ABG, and electrolytes

Expert Consult
- Consider STAT Cardiology consult for rhythm diagnosis, treatment, and disposition

END

VFIB / VTACH

No pulse **AND** **VFIB** **or** **VTACH** 

TREATMENT

Task	Actions
Crisis Resources	• Inform team • Identify leader • Call a code • Call for code cart
CPR	• Rate 100 - 120 compressions/min, minimize breaks • Depth ≥ 5 cm; allow chest recoil; consider backboard • **Keep $EtCO_2$ > 10 mmHg and diastolic BP > 20 mmHg** • Rotate compressors with rhythm check every 2 min. If changes to non-shockable rhythm: **See Asystole/PEA #1** • Check pulse ONLY if signs of ROSC (sustained increased $EtCO_2$, spontaneous arterial waveform, rhythm change) • Prone CPR at lower edge of scapula OK if airway secured
Airway	• **100% O_2 10 - 15 L/min** • Defibrillation is higher priority than intubation. Mask ventilate with ratio of 30 compressions to 2 breaths • If airway secured: 10 breaths/min; tidal volume 6 -7 mL/kg
Defib	• Place pads and **immediately defibrillate: 120-200 J biphasic or 360 J monophasic** • Resume CPR. Increase electrical energy and repeat shock every 2 min
IV Access	• Ensure functional IV or IO access
Meds	• **Turn off volatile anesthetic and vasodilating drips** • **After 2nd shock: epinephrine** 1 mg IV every 3 - 5 min • **After 3rd shock: amiodarone** 300 mg IV push or lidocaine 1 - 1.5 mg/kg IV. May redose: amiodarone 150 mg or lidocaine 0.5 - 0.75 mg/kg • If hypomagnesemia or torsades: magnesium 1 - 2 g IV • If hyperkalemia: calcium chloride 1 g IV; sodium bicarbonate 1 amp IV (50 mEq); regular insulin 5 - 10 units IV with dextrose/D50 1 amp IV (25 g)
H's & T's	• Consider treatable causes on next page
ECMO/CPB	• Consider ECMO or cardiopulmonary bypass
Post Arrest	• If ROSC: arrange ICU care and consider cooling

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DIFFERENTIAL DIAGNOSIS

TEE / TTE and labs will aid diagnosis; Invite input from team

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- Desufflate abdomen
- Remove surgical retractors and sponges
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Hypovolemia
- Give rapid IV fluid bolus
- Check Hgb
- If anemia or hemorrhage:
  See Hemorrhage #12
- Consider relative hypovolemia:
  - If auto-PEEP: disconnect circuit
  - IVC compression
  - Obstructive or distributive shock

  See Anaphylaxis #5

  See High Spinal #14

Hypoxemia
- O_2 100% 10 - 15 L/min
- Check breathing circuit connections
- Confirm ETT placement with CO_2
- Check breath sounds
- Suction ET tube
- Consider chest x-ray; bronchoscopy

  See Hypoxemia #17

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- Consider bicarbonate
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- Actively warm: forced air, warm IV fluid, warm room
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- Consider emergent coronary revascularization

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  See Embolism #9

  See Right Heart Failure #24

END

Anaphylaxis

Severe hypotension	**Angioedema**	**Rash**
Cardiac arrest	**Airway swelling**	**Itching**
Bronchospasm	**Tachycardia**	**Hives (or no skin findings)**
Wheezing	**Arrhythmia**	
High inspiratory pressure	**Flushing**	

TREATMENT

Task	Actions
Crisis Resources	• Inform team • Identify leader • Call for code cart • Consider pausing procedure
Airway	• **100% O_2 10 - 15 L/min** • Secure airway. If angioedema: consider early intubation
IV Access	• Ensure functional large bore IV or IO access

Primary Meds	• **Give epinephrine** to prevent mast cell degranulation:
	  • **Epinephrine** 10 - 100 mcg IV (if no IV: 500 mcg IM); Increase IV dose every 2 min until clinical improvement. May require > 1mg. Start early epinephrine infusion
	  See Infusion List #29
	• If hypotensive: turn off volatile anesthetics and vasodilating drips and consider amnestic agent (e.g. midazolam)

Fluid	• **Give rapid IV fluid bolus.** May require many liters • Consider head down position; elevate legs
Stop Allergens	• **Remove allergens:** e.g. antibiotics, muscle relaxants, chlorhexidine, dyes, blood products, latex, contrast, colloids, protamine, sugammadex

ACLS	• Check pulse. If no pulse or SBP < 50 mmHg:
	  • CPR rate 100 - 120 compressions/min
	  • Depth ≥ 5 cm; allow chest recoil; consider backboard
	  • **Keep $EtCO_2$ > 10 mmHg and diastolic BP > 20 mmHg**
	  • Rotate compressors with rhythm check every 2 min
	  • Check pulse ONLY if signs of ROSC (sustained increased $EtCO_2$, spontaneous arterial waveform, rhythm change)
	  • If mask ventilation: ratio 30 compressions to 2 breaths
	  • If airway secure: 10 breaths/min; tidal volume 6 -7 mL/kg
	  • Place defibrillator pads in case rhythm changes
	  • Consider ECMO or cardiopulmonary bypass

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Anaphylaxis

RULE OUT

- Anesthetic overdose
  See Local Anesthetic Toxicity #18
- Aspiration
- Distributive or obstructive shock
- Embolism e.g. air, clot, fat
  See Embolism #9
- Hemorrhage
  See Hemorrhage #12
- Hypotension
  See Hypotension #16
- Myocardial infarction
  See Myocardial Ischemia #20
- Pneumothorax
  See Pneumothorax #22
- Sepsis

TREATMENT

Task	Actions
Additional Access	• Consider additional IV access • Consider arterial line placement

Secondary Meds	• If hypotension: Continue **epinephrine infusion**. May add **vasopressin** and/or **norepinephrine**
	See Infusion List #29
	• If bronchospasm, give bronchodilator:
	  • If unable to ventilate, treat intravenously: **epinephrine** 5 - 10 mcg IV (or 200 mcg subq) or **ketamine** 10 - 50 mg IV (or 40mg IM) or **magnesium** sulfate 1 - 2 g IV
	  • If able to ventilate: **albuterol** 4 - 8 puffs MDI or 2.5 mg nebulized and **sevoflurane** titrated to 1 MAC
	• If persistent bronchospasm, consider:
	  • H_1 antagonist: **diphenhydramine** 25 - 50 mg IV
	  • H_2 antagonist: **famotidine** 20 mg IV
	  • Corticosteroid: **hydrocortisone** 100 mg IV or **methylprednisolone** 125 mg IV

ECHO	• Consider TEE / TTE to assess volume status and function
Labs	• Send peak serum tryptase 1 - 2 hr after reaction onset
Dispo	• Monitor for at least 6 hr. If severe, biphasic response is more likely so monitor in ICU for 12 - 24 hours • If intubated: consider keeping intubated
Allergy Follow-up	• Consider adding allergens to patient's allergy list • Refer the patient for follow-up allergy testing

END

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Bronchospasm

Inability to ventilate
High peak inspiratory pressure
Wheezing
Absent breath sounds if severe
Increased expiratory time
Increased $EtCO_2$
Upsloping $EtCO_2$ waveform
Decreased tidal volumes
Hypotension if air-trapping

TREATMENT

Task	Actions
Crisis Resources	• Inform team • Identify leader • Consider pausing procedure • Calling for code cart
Early Actions	• If hypotensive, **may be air-trapping:** briefly disconnect circuit • If hypotension, tachycardia, and/or rash: **See Anaphylaxis #5**
Airway	• **100% O_2 10 - 15 L/min** • If stridor or hypoxemia: consider intubation • Optimize exhalation: change I:E ratio (e.g. 1:3 or 1:4) minimize PEEP (0 - 5 cmH_20); avoid hyperinflation (goal tidal volume is 6 mL/kg)
Deepen Anesthesia	• **Bolus propofol;** increase **sevoflurane or isoflurane** • Consider additional **neuromuscular blockade**
Check Airway	• Check CO_2 waveform to confirm airway placement • Auscultate lungs to check for endobronchial intubation • Soft suction ET tube to check for kinking or mucous plug • Check for malpositioned supraglottic airway
Meds	• If severe: **epinephrine 5 - 10 mcg** IV every 3 - 5 min or 200 mcg subq, escalate doses as needed. Consider adding **glycopyrrolate** 0.2 - 0.4 mg IV. Monitor for tachycardia and hypertension • If stridor or tachycardia concerns: give nebulized **racemic L-epinephrine** 0.5 mL of 2.25% soln in 3 mL saline • If able to ventilate, give bronchodilators: **albuterol** 4 - 8 puffs MDI or 2.5 mg nebulized with or without **ipratropium** • Consider giving **ketamine** 10 - 50 mg IV, **magnesium** sulfate 1 - 2 g IV, or **hydrocortisone** 100 mg IV
Labs	• Consider ABG and serum tryptase
ECMO/CPB	• If severe: consider ECMO or cardiopulmonary bypass

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Delayed Emergence

Patient less responsive than expected during emergence
Abnormal neurological exam in postoperative period

TREATMENT

Task	Actions
Crisis Resources	• Inform team
Stop Meds	• **Confirm all volatile and IV anesthetics are off**
Vital Signs	• Check for and correct any hypoxemia, hypercarbia, hypothermia, or hypotension • Check for signs of high ICP: widened pulse pressure (increased systolic, decreased diastolic), bradycardia, irregular respirations
Paralysis	• Check for and **reverse** residual neuromuscular paralysis with sugammadex or neostigmine with glycopyrrolate
Neuro Exam	• Perform neurological exam • Check for pupil changes, motor asymmetry, and gag • **If abnormal or suspect stroke:** Call Stroke Code or equivalent if available, obtain STAT head CT scan and/or STAT Neurology/Neurosurgery consult
Med Reversal	• Consider opioid reversal: **naloxone** 40 mcg IV; may double dose and repeat every 2 minutes up to 400 mcg • Consider benzodiazepine reversal: **flumazenil** 0.2 mg IV every 1 minute; max dose 1 mg • Consider anticholinergic syndrome (e.g. scopolamine): **physostigmine 1 mg IV with atropine available** for cholinergic crisis with severe bradycardia • Re-treat because reversal agents have short half lives
Sugar	• Check for and correct **hypoglycemia**
Labs	• Send ABG plus electrolytes to evaluate for hypercarbia, hyponatremia, hypernatremia, and hypercalcemia
Medication	• Check for possible medication error • Consider delayed med clearance (e.g. hepatic, renal)
Rare Causes	• Consider high spinal, serotonin syndrome, malignant hyperthermia, myxedema coma, seizure, thyroid storm, and hepatic/uremic encephalopathy
Follow-up	• If residual mental status abnormalities, monitor patient in ICU with neurologic follow up

END

Difficult Airway / Cric

Failed laryngoscopy or difficulty oxygenating or ventilating

TREATMENT

Task	Actions
Crisis Resources	• Inform team • Call for airway help • Call for anesthesia tech • Call for difficult airway cart
Optimize Conditions	• Ensure paralysis (e.g. rocuronium 1.2 mg/kg) • Ensure anesthetic depth (e.g. re-bolus or infuse propofol) • Optimize positioning (e.g. sniffing position, head of bed elevation to 30°, neck extension, bed height)

Oxygenate	• Do not fixate on intubation
	• Monitor CO_2 return by capnography and SpO_2
	• **If SpO_2 critically low at any time: go to red box below**
	• Consider oxygenation modalities (max 2 attempts each):
	  • **Mask:** use two-handed grip; insert oral/nasal airway
	  • **Supraglottic airway SGA/LMA:** optimize size and fit (change position of head or device, cuff inflation); consider 2nd generation
	  • **Laryngoscopy:** video preferred. Consider alternate blade, rigid stylet, bougie, external laryngeal manipulation, release of cricoid pressure
	• Choose experienced operator and familiar equipment

Can Oxygenate:

- Monitor CO_2 return by capnography and SpO_2
- **If cannot oxygenate at any time: go to red box**
- While oxygenating, options include:
  - Awaken patient
  - Finish case with SGA/LMA or mask
  - Intubate through SGA/LMA
  - Combined video/fiberoptic
  - Other advanced airway techniques

Cannot Intubate, Cannot Oxygenate (CICO):

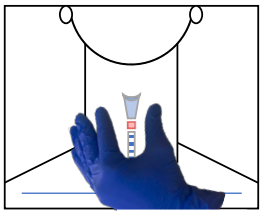
- **Priority is cutting the neck!**
- Call for Cric-capable help
- Get Cric kit: scalpel (e.g. #10 blade), bougie, and 6.0 ET tube
- Additional operator can attempt to oxygenate from above (e.g. mask, SGA/LMA, video laryngoscopy)
- **Start Cric/eFONA (next page)**

CRIC / eFONA ON NEXT PAGE »

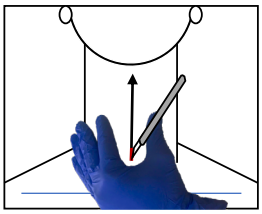
Difficult Airway / Cric

CRIC / EMERGENCY FRONT OF NECK ACCESS (eFONA)

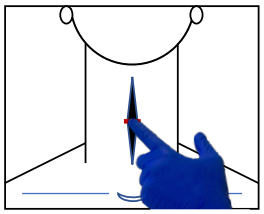
Inform Team	• Announce emergency cric / front of neck access
Call for Help	• ENT, Gen Surgery, ICU, Anesthesiology, Code Team
Prep	• Expose and **extend neck** • Obtain **scalpel, bougie, and lubricated 6.0 ET tube**
Meds	• Give **paralytic** and anesthetic
Oxygenate and Monitor	• Additional operator can attempt to oxygenate from above (e.g. mask, SGA/LMA, video laryngoscopy) • Monitor vital signs and pulse



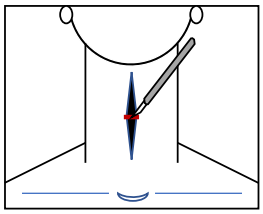
1. Expose and extend neck. Laryngeal handshake to identify midline



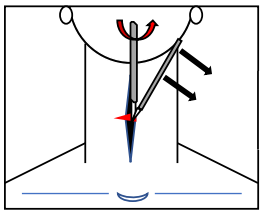
2. Make 8 cm long vertical midline skin incision. Cut away from your hand



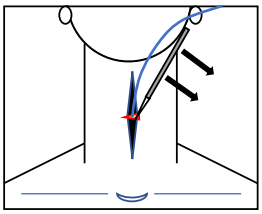
3. Palpate cricothyroid membrane



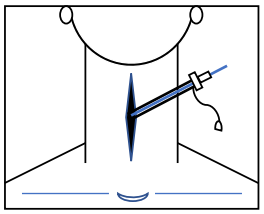
4. Stab horizontally through cricothyroid membrane. Extend to width of trachea



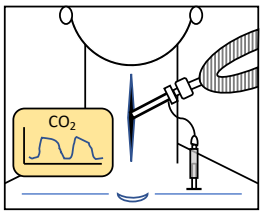
5. Rotate scalpel 90° (blade toward patient's feet) and pull toward you



6. Insert bougie along scalpel. Remove scalpel



7. Pass 6.0 ET tube over bougie



8. Inflate cuff, ventilate, confirm CO_2, check breath sounds

PREVENTION

If risks for difficult airway, make contingency plans and consider:

- Advanced airway equipment in room (e.g. difficult airway cart, second generation SGA/LMA, intubating SGA/LMA, intubation catheter, fiberoptic bronchoscope, rigid bronchoscope, scalpel/bougie cric kit)
- Awake intubation
- High flow apneic oxygenation
- Video laryngoscopy as first attempt
- ENT or General Surgery in room
- Awake tracheostomy (in consultation with surgeon)
- ECMO pre-cannulation with perfusionist in room

END

Embolism - Pulmonary

Sudden decrease in $EtCO_2$, BP, or SpO_2
Sudden increase in central venous pressure
Dyspnea, respiratory distress, or cough in awake patient
Increased risk in long bone orthopedic surgery, pregnancy, cancer (especially renal tumor), high BMI, laparoscopic surgery, or surgical site above level of the heart

TREATMENT

Task	Actions
Crisis Resources	• Inform team • Identify leader • Call for help • Get code cart • Consider terminating procedure
Pulse Check	• **If no pulse:** start CPR, check rhythm, and follow appropriate algorithm **See Asystole/PEA #1** **VFIB/VTACH #4**
Airway	• **100% O_2 10 - 15 L/min**
Circulation	• **Turn off volatile anesthetic and vasodilating drips** • **Give IV vasopressor bolus** to support circulation • Consider rapid fluid bolus
Evaluate Right Heart	• If unstable or RV function decreased on TEE / TTE, use medication and diuresis to: • Maintain sinus rhythm • Maintain normal RV volume status • Maintain RV contractility • Decrease RV afterload **See Right Heart Failure #24**
ECMO/CPB	• If severe decompensation: consider ECMO or cardiopulmonary bypass

RULE OUT

Consider other causes:

- Anaphylaxis
  See Anaphylaxis # 5
- Bone cement implantation syndrome
- Bronchospasm
  See Bronchospasm #6
- Cardiac tamponade
- Cardiogenic shock
- Distributive shock
- Hypovolemia
- Myocardial ischemia
  See Myocardial Ischemia #20
- Pneumothorax
  See Pneumothorax #22
- Pulmonary edema

GO TO NEXT PAGE »

Embolism - Pulmonary

TREATMENT

Further management depends on embolism type:

Pulmonary Thromboembolism:

Risk Factors
- Chronic illness, neoplasm, immobility, missed anticoagulation

Treatment
- Discuss feasibility and safety of **urgent thrombolysis vs. thrombectomy** with surgical team
  - Thrombolysis: If safe, use recombinant tissue plasminogen activator (rtPA) alteplase 10 mg IV followed by infusion of 90 mg over 2 hours
  - Thrombectomy: Consider STAT Cardiovascular Surgery consult (open) or STAT Interventional Radiology consult (percutaneous)
- Supportive treatment: airway, breathing, circulation

Air or CO_2 Embolism:

Signs
- Air visible on TEE / TTE

Treatment
- **Limit entrainment of air:** check IV lines for air; flood surgical field with saline; consider placing surgical site below heart; consider left lateral decubitus position
- **Attempt removal of air:** aspirate air from central line if present
- Supportive treatment: airway, breathing, circulation
- Consider hyperbaric oxygen treatment

Cement or Fat Embolism:

Signs
- **Petechial rash**
- Confusion or irritability if awake

Treatment
- Supportive treatment: airway, breathing, circulation

Amniotic Fluid Embolism:

Signs
- Peripartum patient with maternal or fetal compromise: altered mental status, hypotension, hypoxemia, seizures, coagulopathy

Treatment
- Supportive treatment: airway, breathing, circulation
- Monitor fetus and consider urgent Cesarean section
- Monitor for and treat seizures and DIC

END

Fire - Airway

Sudden pop, spark, flame, smoke, heat, or odor

TREATMENT

Task	Actions
Crisis Resources	• Inform team • Identify leader • Call for help
Anesthesia Professional Immediate Response	• **Disconnect breathing circuit** from the anesthesia machine to prevent torch formation • **Stop fresh gas flow**
Surgeon Immediate Response	• **If clamp immediately available: clamp ET tube. If clamp not available: fold (kink) ET tube** (prevents torch formation if circuit not yet disconnected) • **Immediately remove ET tube** and any airway foreign bodies • **Pour saline into airway** and suction debris
Check Extent of Fire	• If fire spreads beyond airway (e.g. to drapes, patient): **See Fire - Non-Airway #11**
After Fire Extinguished	• **Re-establish oxygenation** when fire is extinguished • Minimize FiO_2 as much as possible. Consider air ventilation • **Consider prompt reintubation with ET tube ≥ 7.0 mm ID** prior to swelling • Ensure adequate anesthesia: e.g. propofol infusion • Perform bronchoscopic examination of entire airway to assess injury and remove residual debris • Inspect ET tube pieces to verify none left in airway • Save all materials for later investigation • Consider steroid: e.g. dexamethasone 8 mg IV
Disposition	• ICU care for prolonged mechanical ventilation and airway observation

FIRE PREVENTION ON NEXT PAGE »

Page 2 Fire - Airway

PREVENTION

Fire Risk = Fuel Source + Oxidizer + Ignition Source

For All High Risk Procedures	• Discuss fire prevention and response during time out • Avoid FiO_2 > 0.3 and avoid N_2O • Anesthesia provider: communicate FiO_2 changes • Surgeon: communicate use of laser or electrocautery
For Laser Surgery of Vocal Cord or Larynx	• Use laser resistant ET tube (single or double cuff) • Ensure ET tube cuff is sufficiently below vocal cords • Consider filling proximal ET tube cuff with methylene blue-tinted saline • Surgeon: keep laser in standby when not in use • Surgeon: protect ET tube cuff with wet gauze • Surgeon: check FiO_2 < 0.3 and N_2O not in use before lasering or electrocauterizing • Anesthesia provider: communicate FiO_2 changes
For Non-laser Surgery in Oropharyx	• Regular PVC ET tube may be used • Surgeon: protect ET tube with wet gauze • Consider continuous suctioning inside oropharynx • Surgeon: confirm FiO_2 < 0.3 and no N_2O prior to electrocautery use • Anesthesia provider: communicate FiO_2 changes

END

Fire - Non-Airway

Sudden pop, spark, flame, smoke, heat, or odor

TREATMENT

Task	Actions
Crisis Resources	• Inform team • Activate fire alarm • Get CO_2 fire extinguisher • Call for help • Call code red
Prevent Airway Fire	• **Stop fresh gas flow** • **Disconnect breathing circuit** from the anesthesia machine to stop all airway gas flow • Ventilate with portable self-inflating bag (Ambu) on room air
Prevent Patient Harm	• **Remove all burning and flammable materials** (e.g. drapes, fabrics) from patient and onto floor; extinguish any flames

Extinguish Flames (PASS)	• If **non-electrical** fire: use CO_2 fire extinguisher (safe for wound) and saline or water (e.g. from basin, bottles, IV bags)
	• If **electrical** fire: use only CO_2 fire extinguisher
	  • PULL: Pull the pin
	  • AIM: Aim for the base of the fire
	  • SQUEEZE: Squeeze the trigger in five second bursts
	  • SWEEP: Sweep from side-to-side to put out fire

Care for Patient	• Assess for injuries; monitor vital signs • Ensure adequate anesthesia e.g. propofol infusion
Consider Evacuation	• If continued smoke or fire: evacuate patient and staff • If no smoke or fire: stay and shelter in place
Contain Fire	• Close operating room doors • Turn off external gas supply valves for O_2 and N_2O
Check Extent of Fire	• If fire spreads to airway: **See Fire - Airway #10**
Team Recap	• Discuss with surgeon and OR leadership the implications of fire for this patient and OR schedule

FIRE PREVENTION ON NEXT PAGE »

Page 2 Fire - Non-Airway

PREVENTION

Fire Risk = Fuel Source + Oxidizer + Ignition Source

For All High Risk Procedures	• Discuss fire prevention and management during time out • Avoid FiO_2 > 0.3 and avoid N_2O • Communicate FiO_2 changes and electrocautery or laser use throughout case
For Highest Risk: MAC Head and Neck Procedures	• Use minimum O_2 concentration for adequate SpO_2 • Use nasal cannula instead of face mask if able • If high O_2 concentration required: use LMA or ET tube • Configure drapes to avoid O_2 build up, consider active scavenging if required • Allow complete drying of alcohol skin prep solutions

END

Hemorrhage

Increased suction volume
Increased surgical sponge use
Tachycardia
Hypotension

TREATMENT

Task	Actions
Crisis Resources	• Inform team • Identify leader • Call for Anesthesiology, Surgery, and Nursing help • **Activate Massive Transfusion Protocol (MTP)**
Early Response	• Give **IV fluid** bolus (e.g. crystalloid, colloid). If significant hemorrhage: **prioritize transfusion** of blood products • Establish **large bore IV access:** consider IO or central venous access • Temporize severe hypotension with **vasopressor** bolus • Consider **head down position** or leg elevation
Airway	• **100% O_2 10 - 15 L/min** • Consider intubation prior to airway swelling

Critical Response	• If severe hemodynamic instability at any point:
	  • Inform surgeon and **suggest surgical temporizing measures** (e.g. packing, major vessel compression or crossclamp, hemostatic agents: thrombin or fibrin glue)
	  • **Get additional surgical help** (e.g. Trauma, Vascular, Cardiac, Gyn-Onc, or General Surgery)

Rapid Infuser and Cell Saver	• Delegate setup of:
	  • Rapid infusion system
	  • Cell saver (if surgical site is not contaminated or cancerous)

Transfuse	• If significant bleeding: transfuse, do not wait for lab results • Check all blood • Based on clinical picture: transfuse with ratio of **1-2 PRBC : 1 FFP : 1 Platelet pack** • Adjust empiric transfusion for any clinical or laboratory signs of coagulopathy

GO TO NEXT PAGE »

Hemorrhage

TREATMENT

Task	Actions
Normothermia	• Warm room, use warm fluid, forced air, and blankets
Arterial Line	• Consider arterial line placement for monitoring and serial lab draws
Urine Output	• Place foley. Urine output goal ≥ 0.5 mL/kg/hr
Labs	• Monitor resuscitation adequacy with clinical stability and serial labs: Hgb, platelets, coagulation, acid base status, base deficit, electrolytes, lactate, TEG, Rotem • Actively **maintain normal calcium** level

BLOOD PRODUCTS AND THERAPEUTIC ADJUNCTS

PRBC	• Give if Hgb < 7 - 10 g/dL depending on hemodynamic stability, coronary disease, and rate of blood loss • Each unit should raise Hgb ~ 1g/dL or HCT ~ 3%
FFP	• Give if INR or PTT > 1.5x normal • Give FFP 10 - 15 mL/kg then recheck labs and continue with 1:1 PRBC : FFP ratio
Platelets	• Give if platelets < 50 - 100 K/uL and ongoing bleeding • Each apheresis unit should raise platelet count ~50 K/uL
Cryo-precipitate	• Give if fibrinogen < 80 - 100 mg/dL (< 300 mg/dL peripartum) • Each 10 units of cryoprecipitate should raise fibrinogen level ~50 mg/dL
Fibrinogen Concentrate	• If cryoprecipitate unavailable: consider fibrinogen concentrate 0.5 - 1 g IV. May repeat to fibrinogen goal • Each gram should raise fibrinogen level ~50 mg/dL
Tranexamic Acid	• Consider TXA in all major bleeding cases • Give 1 g IV over 10 min then 1 g IV over 8 hours
Prothrombin Complex Concentrate	• Consider PCC in patients with warfarin induced bleeding or persistent deranged INR (PT) • Give 25 - 50 units/kg IV
Factor VIIa Concentrate	• Consider Factor VIIa if life-threatening, refractory coagulopathy • Seek hematology or pharmacy advice for dosing

END

High Airway Pressure

Increased peak airway pressures > 5 cm H_2O above baseline or > 35 cm H_2O

May be accompanied by:
- **Wheezing and upsloping CO_2 waveform (if bronchospasm)**
- **Increased $EtCO_2$**
- **Decreased tidal volumes**
- **Hypotension (if air-trapping)**

TREATMENT

Task	Actions
Crisis Resources	• Inform team • Identify leader • Call for help

Airway	• **100% O_2 10 - 15 L/min**
	• Confirm presence of CO_2
	• Evaluate capnography waveform:
	  • Upward slope suggests obstruction
	  • Curare cleft near end of expiratory phase suggests insufficient neuromuscular blockade
	• Starting at patient: inspect breathing circuit including valves, connections, and sample line

Rule Out Air Trapping	• Disconnect breathing circuit from ET tube or SGA/LMA to **rule out air-trapping** (i.e. auto-PEEP)

Localize Problem	• **During disconnect, squeeze reservoir bag.** If pressure is:
	  • **High** (machine or circuit is obstructed): **Switch to self-inflating bag (Ambu)** connected to O_2 source and gas sampling line
	  • **Low or zero** (problem is with the ET tube or lungs): **Reconnect anesthesia machine circuit**

Optimize Compliance	• Consider increasing anesthetic: e.g. **propofol** 20 mg IV • Consider additional neuromuscular blockade • If abdominal insufflation: decrease or release pressure • Evaluate patient position. If head down: consider level or head-up positioning. If prone: consider turning supine • If surgical retraction contributing: notify surgeon • Check for shift in patient position (e.g. slipping off prone position supports)

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High Airway Pressure

TREATMENT

Task	Actions
Manually Ventilate	• Manually ventilate using anesthesia machine to assess compliance • Check and adjust adjustable pressure-limiting valve (APL)
Check for ET Tube Obstruction	• Pass soft suction catheter to rule out kinked ET tube or thick secretions (i.e. mucous plug) • Consider bronchoscopy to evaluate ET tube and airway • If unable to clear ET tube obstruction: replace ET tube

Auscultate Breath Sounds	• If asymmetric:
	  • Rule out endobronchial intubation
	  • Rule out pneumothorax
	  See Pneumothorax #22
	• If symmetric but abnormal breath sounds:
	  • If wheezing or decreased breath sounds: consider bronchospasm treatment
	  See Bronchospasm #6
	  • If crackles: consider pulmonary edema treatment

RULE OUT

Potential Causes

ET tube or lungs:

- Abdominal compartment syndrome
- Abdominal insufflation
- Abnormal anatomy (e.g. kyphoscoliosis)
- Airway foreign body
- Airway tumor
- Anaphylaxis

See Anaphylaxis #5

- Aspiration
- Bronchospasm

See Bronchospasm #6

- Chest wall rigidity
- Kinked ET tube or circuit
- Laryngospasm
- Light anesthesia
- Mucous plug
- Muscle tone
- Patient positioning
- Pleural effusion
- Pneumothorax/hemothorax

See Pneumothorax #22

- Pulmonary edema
- Thoracic insufflation

Machine or breathing circuit:

- Circuit obstruction
- Scavenger closed
- Ventilator valve malfunction

END

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High Spinal

After neuraxial anesthesia or analgesia:

- **Sensory or motor blockade higher or faster than expected**
- **Upper extremity numbness or weakness (hand grip)**
- **Dyspnea or apnea**
- **Nausea or vomiting**
- **Difficulty swallowing**
- **Cardiovascular collapse: bradycardia and/or hypotension**
- **Loss of consciousness**

TREATMENT

Task	Actions
Crisis Resources	• Inform team • Identify leader • Call a code • Get code cart
Pulse Check	• **If no pulse: start CPR and see** **Asystole/PEA #1** or **VFIB/VTACH #4**
Airway	• **100% O_2 10 - 15 L/min** • Support oxygenation and ventilation; intubate if necessary as respiratory compromise may last several hours. Patient may be conscious and need reassurance and an amnestic agent, such as midazolam, to prevent awareness
Circulation	• If severe bradycardia or hypotension: **epinephrine** 10 - 100 mcg IV, increase as needed • If mild bradycardia: consider **atropine** 0.5 - 1 mg or **glycopyrrolate** 0.2 - 0.4 mg, but progress quickly to epinephrine if needed. Phenylephrine unlikely to be effective
Rapid Preload	• Give **rapid IV bolus** with pressure bag. May require several liters • Raise both legs to increase preload • Maintain neutral position. Head down position increases venous return but increases already high spinal level
Pregnancy Specific Care	• Ensure left uterine displacement • Call OB and Neonatology teams • Prepare for emergent or perimortem Cesarean • Monitor fetal heart tones

RULE OUT

- If local anesthetic toxicity is possible: give lipid emulsion 20% rapidly and **See Local Anesthetic Toxicity #18**

END

Hypertension

High systolic or diastolic blood pressure refractory to initial intervention

TREATMENT

Task	Actions
Crisis Resources	• Inform team • Identify leader • Call for help • Consider pausing procedure
Airway	• **100% O_2 10 - 15 L/min**
Check BP Accuracy	• Check arterial line transducer position; consider zeroing • Check NIBP cuff position; cuff or cable compression

RULE OUT

Periop Causes

- Surgical stimulus: inspect surgical field
- Recent epinephrine (e.g. local anesthesia, pledgets) or another vasopressor (e.g. vasopressin) given in surgical field
- Carotid or aortic clamping
- Full bladder / kinked urine catheter
- Hypercarbia
- Inadequate anesthesia or analgesia, including empty vaporizer or failure to deliver IV anesthetic
- Inappropriate arterial line transducer height
- Medication error
- Pneumoperitoneum
- Prolonged tourniquet time
- Rebound hypertension in known hypertensive patient

TREATMENT

Task	Actions
Treat Reversible Causes	• If acute self-limited cause (e.g. epinephrine): consider waiting • **Treat reversible causes before giving antihypertensive** • If treatable cause (e.g. tourniquet, full bladder): treat cause

Temporize	• Depending on clinical context and heart rate:
	  • Increase anesthetic depth
	  • Consider head up position

GO TO NEXT PAGE »

Page 2 Hypertension

TREATMENT

Task	Actions

Meds	• Ensure functional IV; directly treat blood pressure:
	  • **Labetalol** 5 - 10 mg IV, wait 5 min for next dose
	  • **Hydralazine** 2 - 5 mg IV, wait 15 min for next dose
	  • **Nitroglycerin** 20 - 50 mcg IV, wait 3 min for next dose
	  • **Nitroprusside** 20 - 50 mcg IV, wait 3 min for next dose
	• Infusion with carrier to maintain blood pressure control: e.g. clevidipine infusion starting at 1 - 5 mg/hr
	See Infusion List #29

Arterial Access	• If severe or sustained hypertension: consider placing arterial line for monitoring and labs
Labs	• Send samples for ABG, Hgb, electrolytes, lactate, troponin
ECG	• Follow for signs of myocardial ischemia: (e.g. ST changes, T-wave inversions, or new arrhythmias) **See Myocardial Ischemia #20**
Team Recap	• Discuss patient condition with surgeon and team • Discuss adjustments of surgical plan
Disposition	• Arrange ICU care if vasoactive infusions or prolonged arterial line blood pressure monitoring indicated

RULE OUT

Rare Causes

- **Autonomic hyperreflexia:** spinal cord injury above T6, painful stimuli below cord injury level, reflex bradycardia
- **Ischemia:** new arrhythmia, ST change or T-wave inversion
  See Myocardial Ischemia #20
- **Malignant hyperthermia:** muscle rigidity; profound mixed respiratory and metabolic acidosis
  See Malignant Hyperthermia #19
- **Neuroleptic malignant syndrome:** medical history of dopamine antagonist use, muscle rigidity, hyperthermia
- **Pheochromocytoma:** episodic, resistant to treatment
- **Preeclampsia:** pregnant, proteinuria, edema
- **Raised ICP:** dilated pupil(s), bradycardia, trauma
- **Serotonin syndrome:** hyperthermia, tachycardia, rigidity
- **Stroke**
- **Thyroid storm:** tachycardia, diaphoresis

END

Hypotension

Low blood pressure refractory to intervention or unclear cause

TREATMENT

Task	Actions
Crisis Resources	• Inform team • Consider pausing procedure • Call for help • Consider calling for code cart
Pulse and Monitor Check	• Check for vital sign and $EtCO_2$ abnormalities • **If no pulse or abnormal rate or rhythm, consider:** **Asystole/PEA #1** **Bradycardia #2** **SVT #3** **VFIB/VTACH #4** • Check arterial line, transducer position, and cycle NIBP
Inspect Surgical Field	• Check for visible or concealed hemorrhage; consider FAST **See Hemorrhage #12** • Check surgical field for pressure on heart or great vessels
Early Actions	• Ensure functional IV or IO access; start **rapid crystalloid or colloid bolus** • Consider **head down position** or leg elevation
Meds	• **Turn anesthetic down or off** • If **ephedrine** 5 - 20 mg IV or **phenylephrine** 100 - 300 mcg IV is not effective: consider **epinephrine** 10 - 50 mcg IV and/or **vasopressin** 0.5 - 1 units IV. May repeat or start infusion • Consider slow bolus of **calcium** chloride 1 g or calcium gluconate 1 - 3 g • Consider treating adrenal insufficiency: **hydrocortisone** 100 mg IV or **methylprednisolone** 125 mg IV • Consider treating vasoplegia: **methylene blue** 1.5 - 2 mg/kg over 20 min - 1 hour
Airway	• **100% O_2 10 - 15 L/min**
Cardiac Workup	• Consider TEE / TTE to differentiate causes • If persistent hypotension: consider ECMO or bypass
Access	• Consider additional large bore IV access • Consider arterial line placement
Labs	• Check ABG, Hgb, Plt, glucose, calcium, potassium, lactate
Output	• Place foley catheter and monitor urine output

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Page 2 Hypotension

DIFFERENTIAL DIAGNOSIS

Rule out rapidly lethal causes:

- Anaphylaxis
  See Anaphylaxis #5
- Auto-PEEP: disconnect circuit
  See High Airway Pressure #13
- Cardiovascular: consider TEE / TTE to evaluate volume status, LV/RV function, valvular disease, LV outflow obstruction
  See Embolism #9
  See Myocardial Ischemia #20
  See Right Heart Failure #24
- Hemorrhage or concealed hemorrhage
  See Hemorrhage #12
- IVC compression: prone, obese, pregnant, surgical manipulation
- Local anesthetic toxicity
  See Local Anes Toxicity #18
- Pneumoperitoneum or pneumopericardium
- Pneumothorax
- Cardiac tamponade
  See Pneumothorax #22
- Vasodilators: check doses of volatile/IV anesthetics and drips

Explore Other Causes By Physiologic Differential:

- Blood Pressure = Systemic Vascular Resistance (SVR) x Cardiac Output (CO)
- Cardiac Output (CO) = Heart Rate (HR) x Stroke Volume (SV)
- Stroke Volume (SV) components: Preload, Inotropy, Afterload

Low SVR	• Anaphylaxis **See Anaphylaxis #5** • Neuraxial block **See High Spinal #14**	• Shock (septic/spinal/neurogenic) • Transfusion reaction **See Transfusion Reaction #25** • Vasodilators
Low HR	• Bradycardia/heart block • Vagal stimulus	• High spinal **See High Spinal #14**
Low Preload	• Auto-PEEP • Embolism e.g.air,clot,fat **See Embolism #9** • Hypovolemia **See Hemorrhage #12** • IVC compression	• Pericardial tamponade • Pneumothorax **See Pneumothorax #22** • Right heart failure **See Right Heart Failure #24** • Vasodilators
Low Inotropy	• Acidosis • Arrhythmias • Cardiomyopathy • Hypoxemia **See Hypoxemia #17**	• Local anesthetic toxicity **See Local Anes Toxicity #18** • Myocardial depressants • Myocardial ischemia **See Myocardial Ischemia #20**
High Afterload	• Stenotic valvular disease • LVOT obstruction	
Low Forward Flow	• Regurgitant valvular disease	

END

Hypoxemia

Low SpO_2 and/or PaO_2 refractory to intervention or unclear cause

TREATMENT

Task	Actions
Crisis Resources	• Inform team • Consider pausing procedure • Call for help • Consider calling for code cart
Oxygenate	• **100% O_2 10 - 15 L/min**
Check Monitors and Vitals	• Check gas analyzer to rule out low FiO_2 or high N_2O **See Oxygen Failure #21** • Check SpO_2 waveform, probe positioning, limb perfusion • Check vitals: ECG, cycle NIBP, check pulse, airway pressure • Check CO_2 waveform, look for circuit disconnection
Initial ETT Check	• **Manually ventilate** to check compliance • Consider using self-inflating (Ambu) bag with non-machine O_2 source (e.g. e-cylinder) or nothing (room air) to **rule out machine or oxygen supply issue.** Connect sample line and consider IV anesthetic • Check ET tube position and **auscultate breath sounds** **See Bronchospasm #6** • Soft **suction ET tube** to assess secretions and patency
Recruit Alveoli	• Perform **recruitment breaths** • Consider **PEEP.** If hypotensive: use caution • Increase FRC: **head up position, desufflate abdomen**
Meds	• If BP stable: deepen anesthetic with **propofol** or **volatile** • If wheezing: **albuterol** 4 - 8 puffs MDI or 2.5 mg nebulized. If severe: **epinephrine** 5 - 10 mcg IV, or **ketamine** 10 - 20 mg IV • Consider additional neuromuscular blockade or reversal
Advanced Evaluation	• Fiberoptic **bronchoscopy:** confirm tracheal rings, check for endobronchial intubation or obstruction • **Lung ultrasound:** check for pneumothorax, effusion consolidation, interstitial edema
Access	• Consider arterial line placement and ABG
X-Ray	• Consider STAT portable chest x-ray
ECMO/CPB	• If persistent: consider ECMO or bypass

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Hypoxemia

DIFFERENTIAL DIAGNOSIS

Low FiO_2:

- If gas analyzer reads low FiO_2 despite "100% O_2," then likely O_2 pipeline failure or crossover
  See Oxygen Failure #21

Hypoventilation:

- Spontaneously breathing:
  - Bronchospasm
  - Excess anesthetic
  - High spinal
    See High Spinal #14
  - Laryngospasm
  - Obstructed airway
  - Opioid
  - Pain
  - Pulmonary edema
  - Residual neuromuscular blockade
- Mechanically ventilated:
  - High pressure alarm:
    - Asynchronous breathing
    - Bronchospasm
      See Bronchospasm #6
    - High peak airway pressure
      See High Airway Pressure #13
    - Insufficient neuromuscular blockade
    - Obstructed or kinked ET tube
    - Ventilator on manual, APL closed
  - Low pressure alarm:
    - ET tube dislodged or cuff tear
    - Circuit leak
    - Low TV or RR setting
    - Ventilator on manual and APL open

Diffusion abnormality:

- Usually chronic lung disease

Hemoglobinopathy:

- Carboxyhemoglobin: SpO_2 often normal
- Methemoglobin: SpO_2 ~85%
- If suspected, send lab co-oximetry

V/Q Mismatch:

Shunt = perfused, but not ventilated (less responsive to O_2)

Dead space = ventilated, but not perfused (more responsive to O_2)

- Common causes:
  - Aspiration
  - Atelectasis
  - Bronchospasm
    See Bronchospasm #6
  - Endobronchial intubation
  - Mucus plug
  - One lung ventilation
  - Pleural effusion
  - Pulmonary edema
- Rare but critical:
  - Anaphylaxis
    See Anaphylaxis #5
  - Embolism: e.g. air, clot, fat
    See Embolism #9
  - Pneumothorax
    See Pneumothorax #22
  - Right heart failure
    See Right Heart Failure #24
  - Severe hypotension
    See Hypotension #16

Increased O_2 Demand:

- Iatrogenic hyperthermia
- Malignant hyperthermia
  See Malignant Hyperthermia #19
- Neuroleptic Malignant Syndrome
- Sepsis
- Thyrotoxicosis

SpO_2 Artifact:

- Confirm with ABG
- Poor SpO_2 waveform:
  - Cautery interference
  - Cold or poorly perfused digit
  - Light interference
  - Probe malposition
- Dyes:
  - Blue nail polish
  - Indigo carmine
  - Methylene blue

END

Local Anesthetic Toxicity

Can present with any combination of:

Neurologic symptoms:
- **Seizures**
- **Altered mental status**
- **Tinnitus**
- **Metallic taste**
- **Perioral numbness**

Cardiac symptoms:
- **Cardiovascular collapse**
- **Hypotension**
- **Arrhythmia (e.g. ectopy, asystole, bradycardia, VFIB, VTACH)**

TREATMENT

Task	Actions
Crisis Resources	• Inform team • Call for help • **Call for lipid emulsion 20% (Intralipid) STAT** • If unstable: consider early call for ECMO or bypass
Stop Triggers	• Stop any local anesthetic injection or infusion
CPR	• If pulseless: start CPR. May require prolonged CPR +/- ECMO • **100% O_2 10 - 15 L/min** • Start lipid emulsion, then intubate if indicated
Lipid Emulsion	• **Bolus lipid emulsion 100 mL IV over 2 - 3 min** (If < 70 kg: give 1.5 mL/kg IV bolus) • **Infuse lipid emulsion 250 mL IV over 15 - 20 min** (If < 70kg: infuse 0.25 mL/kg/min for 20 min) • **If unstable: repeat bolus and double the infusion until stable.** Maximum lipid emulsion dose 12 mL/kg • Once stable, continue infusion for at least 15 minutes

Post-event Care	• Continue PACU/ICU-level monitoring for at least:
	  • 2 hours after seizure
	  • 6 hours after hemodynamic instability
	  • 24 - 48 hours after cardiac arrest

Consult ASRA	• For latest recommendations: http://www.asra.com

Next page: Treatment depending on LAST presentation

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Local Anesthetic Toxicity

TREATMENT

If Seizure:	
Recovery Position	• Place patient lateral and head down to prevent aspiration; prevent falls and head injury
Meds	• Give benzodiazepine to break seizure: midazolam 2 - 4 mg IV. If refractory, give neuromuscular blockade: rocuronium • If benzodiazepines not available and BP stable: give propofol 20 mg IV. May repeat until seizure stops
Airway	• Support breathing; intubate if appropriate
If Arrhythmia or Hypotension:	
Rhythm Meds	• If persistent arrhythmia: give amiodarone 150 mg IV slowly over 10 - 15 min. Avoid calcium channel blockers, beta blockers, local anesthetics, and any negative inotrope
Meds	• Treat hypotension with **low dose epinephrine:** start with 0.2 - 1 mcg/kg IV; **avoid vasopressin**
If Cardiac Arrest:	
CPR	• Rate 100 - 120 compressions/min • Depth ≥ 5 cm; allow chest recoil; consider backboard • Keep $EtCO_2$ > 10 mmHg and diastolic BP > 20 mmHg • Rotate compressors with rhythm check every 2 min • Check pulse ONLY if signs of ROSC (sustained increased $EtCO_2$, spontaneous arterial waveform, rhythm change) • Place defib pads
Airway	• If mask ventilation: ratio 30 compressions to 2 breaths • If airway secured: 10 breaths/min; tidal volume 6 - 7 mL/kg
Defib	• If VFIB or unstable VTACH: immediately defibrillate 120-200 J biphasic or 360 J monophasic • Resume CPR immediately • Reasonable to increase energy of repeat shock every 2 min
Meds	• Give **LOW DOSE epinephrine**: start at 0.2 - 1 mcg/kg IV • If VFIB/VTACH unresponsive to defibrillation: **amiodarone** 300 mg IV push. May redose amiodarone 150 mg IV push. **Avoid lidocaine**
ECMO/CPB	• If prolonged need for CPR: **consider ECMO or bypass**

END

Malignant Hyperthermia

May be early signs:	**Mixed (metabolic and respiratory) acidosis** **Increased $EtCO_2$, heart rate, respiratory rate** **Hyperthermia** **Masseter spasm/trismus** **Muscle rigidity without shivering, tremor, or clonus**
May be late signs:	**Myoglobinuria** **Arrhythmias including hyperkalemic cardiac arrest**

TREATMENT

Task	Actions
Crisis Resources	• Inform team • Call for help • Get MH cart with **dantrolene** • Consider pausing procedure
Stop MH Triggers	• **Stop volatile anesthetic and succinylcholine** • **Do NOT change machine or circuit** • **100% O_2 10 - 15 L/min** • If easily available, add charcoal filters to breathing circuit
Airway	• Maximize minute ventilation. Mechanical ventilation is preferred. Avoid air-trapping

Give Antidote Rapidly	• Initial dantrolene dose is 2.5 mg/kg IV. Formulations:
	  • Concentrated, easily soluble formulation:
	  Ryanodex: Dilute one 250 mg vial in 5 mL preservative-free **sterile water.**
	  70 kg patient dose: 175 mg = 3.5 mL
	  • Non-concentrated formulation:
	  Dantrium or Revonto: Assign several people to prepare. Dilute each 20 mg vial in 60 mL preservative-free **sterile water.**
	  70 kg patient dose: 175 mg = 9 VIALS
	• Repeat dantrolene 2.5 mg/kg every 5 min until hypercarbia and rigidity are resolved and temperature is not increasing. May need > 10 mg/kg

Team Recap	• If appropriate, stop procedure • **Give non-triggering maintenance anesthetic or sedation (e.g. propofol, benzodiazepine, opioid)**

RULE OUT

- CO_2 insufflation
- Hypoventilation
- Hypoxemia
- Iatrogenic warming
- Illicit stimulants
- Light anesthesia
- Neuroleptic malignant syndrome
- Pheochromocytoma
- Serotonin syndrome
- Thyroid storm

GO TO NEXT PAGE »

Malignant Hyperthermia

TREATMENT

Task	Actions
Treat Hyper-K+	• **Calcium** chloride 10 mg/kg IV, max 2 g • Regular **insulin** 5 - 10 units IV **with dextrose/D50** 1 amp IV (25 g); monitor glucose • **Albuterol** 8 - 12 puffs MDI or 2.5 mg nebulized • Sodium **bicarbonate**: 0.5 amp (25 mL) at a time; maintain minute ventilation to exhale additional CO_2 produced • If severe: consider emergent dialysis
Treat Rhythm	• Treat arrhythmias with amiodarone 150 mg IV over 10 - 15 min, esmolol 10 - 20 mg IV bolus followed by infusion, or magnesium sulfate 1 g IV; **avoid calcium channel blockers and sodium channel blockers (e.g. verapamil, diltiazem, lidocaine, procainamide)** • If unstable, call for code cart and also see ACLS event: **Asystole/PEA #1** **Bradycardia #2** **SVT #3** **VFIB/VTACH #4**
Active Cooling	• If core temperature > 38° C: **actively cool** with cold IV fluid (20 - 30 ml/kg normal saline or plasmalyte) • Additional cooling: **Stop active warming;** set forced air on ambient; cool room; put ice packs on head, axilla, and groin; wet skin; cool lavage if open abdomen or peritoneal catheter (avoid bladder lavage to preserve urine output measurement)
Access	• Consider additional IV access and arterial line placement
Labs	• Send ABG, K+, CK, urine myoglobin, coagulation panel, lactate
Urine Output	• Place Foley catheter and monitor urine output: goal 1 - 2 mg/kg/hr; consider IV fluids and diuretics
MH Hotline	• Call 24/7 for expert consultation: **1-800-MH-HYPER** (1-800-644-9737) http://www.mhaus.org
ICU Care	• Transport with experienced personnel after stabilization • Mechanical ventilation commonly required because **20% of MH events relapse within 16 hours.** Extubate once metabolically and hemodynamically stable • **Continue dantrolene: 1 mg/kg bolus every 4 - 6 hours or 0.25 mg/kg/hr infusion for up to 24 hours** • Monitor for rhabdo, DIC, hyperK^+, compartment syndrome
Post Event	• Complete AMRA (Adverse Metabolic Reaction to Anesthesia): https://anest.ufl.edu/namhr/ • Test genes: https://www.mhaus.org/testing/genetic-testing/

END

Myocardial Ischemia

ST segment depression or elevation
T-wave inversion
Arrhythmias: conduction abnormality (e.g. new LBBB), irregular rhythm, tachycardia, bradycardia, or hypotension
Regional wall motion abnormality
New or worsened mitral regurgitation
Chest pain, dyspnea, nausea, or diaphoresis

TREATMENT

Task	Actions
Crisis Resources	• Inform team • Get code cart • Call for Cardiac Anesthesiology or Cardiology help
Airway	• **Set supplemental O_2 to maintain $SpO_2 \geq 95\%$**
Monitor	• Get 12-lead ECG; verify ECG leads in correct position • Expand ECG monitor view to leads II, V5, and others • Prepare for arrhythmia: apply defibrillator pads and leads
Team Recap	• Pause or stop procedure if possible • **Discuss bleeding and risk of anticoagulation**

Meds	• Treat any tachycardia, bradycardia, hypotension or hypertension
	See Infusion List #29
	• Discuss with surgeon the explicit contraindications and benefits of dual antiplatelet therapy and anticoagulation:
	  • **Aspirin 160 - 325 mg PO, nasogastric, or rectal**
	  • **P2Y12 ADP receptor inhibitor:** e.g. clopidogrel 300 mg PO, prasugrel 60 mg PO, or ticagrelor 180mg PO
	  • **Heparin infusion**
	• Treat pain with narcotics: **fentanyl or morphine**
	• Consider **nitroglycerin** paste or infusion. Avoid if hypotensive
	• Consider **beta blocker** to slow heart rate and allow coronary perfusion. **Esmolol** preferred because it can be stopped if it precipitates CHF. Avoid if bradycardia, 1st or 2nd degree heart block, or hypotensive
	• If acute pulmonary edema, consider diuresis: furosemide 10 - 40 mg IV. Monitor urine output

GO TO NEXT PAGE »

Page 2 Myocardial Ischemia

TREATMENT

Task	Actions
Cardiology Consult	• If STEMI: consult Cardiology for possible **emergent coronary revascularization** or fibrinolysis • Consider emergent transfer to Cath Lab or PCI Center
Access	• Consider additional IV access • Place arterial line for monitoring and labs • Consider central line placement
Labs	• Send ABG, electrolytes, Hgb, troponin, coagulation panel
ECHO	• Consider **TEE / TTE** to assess volume status, wall motion, ventricular function, and valvular disease • **Use contractility to guide vasoactive infusion choice**
ECMO/CPB	• Consider ECMO, cardiopulmonary bypass, or intra-aortic balloon pump
Disposition	• May require ICU care

END

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Oxygen Failure

Audible or visible O_2 failure alarm
Inappropriately low FiO_2 value on gas analyzer
Flow meter reads abnormally low

TREATMENT

Task	Actions
Crisis Resources	• Inform team • Call for help • Consider pausing procedure • Get code cart with O_2 cylinder
Non-Machine Ventilation	• Disconnect patient from machine and ventilate with **self-inflating bag (Ambu) on room air** • **Do NOT connect self-inflating bag (Ambu) to machine auxiliary oxygen** because it has the same faulty O_2 source • Consider assigning capable person to manual ventilation
Pulse Check	• **If no pulse: start CPR and** **See Asystole/PEA #1**
Non-Machine O_2 Source	• Attach self-inflating bag (Ambu) to: • Nozzle on transport O_2 e-cylinder **OR** • Nothing (continue ventilating on room air)
Attach Gas Sampling Line	• **Connect gas sampling line** with elbow connector between patient and self-inflating bag (Ambu) • Verify correct airway placement with CO_2 • Verify patient is receiving expected O_2 concentration on gas analyzer: 100% if on e-cylinder, 21% if on room air
Low Pressure	• Confirm orogastric/nasogastric tube not in trachea
Non-Machine Anesthetic	• **Maintain anesthesia** with IV medications • Turn off volatile anesthetic
Conserve O_2	• Use lowest possible fresh gas flow and FiO_2
Report Problem	• Inform Charge Nurse, Anesthesia Lead, and all ORs • Contact bio-engineering to: • Report problem; ask for help with diagnostics and repair while you focus on patient care • Find out if issue is system wide
Team Recap	• Discuss plan for this patient and OR schedule

END

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Pneumothorax

Increased peak inspiratory pressures (PIPs)
Tachycardia
Hypotension or hypoxemia
Decreased or asymmetric breath sounds
Hyperresonance to chest percussion
Tracheal deviation (late sign)
Increased JVD/CVP
Decompensation upon initiation of mechanical ventilation or central line placement
Higher incidence in trauma, COPD, cardiothoracic, and upper abdominal surgery patients

TREATMENT

Task	Actions
Crisis Resources	• Inform team • Identify leader • Call for help • Get code cart • Call Trauma, General, or Cardiothoracic Surgery STAT
Airway	• **100% O_2 10 - 15 L/min**
Fast Checks	• Exclude endobronchial intubation: listen to breath sounds and check ET tube depth • Exclude ET tube obstruction: pass soft suction catheter • Exclude auto-PEEP: briefly disconnect breathing circuit

Decompress Emergently	• If unstable and chest tube is not immediately available:
	  • Place 14 (or 16) gauge IV catheter in **4th or 5th intercostal space between anterior and mid-AXILLARY line** per ATLS 2018 (may hear a whoosh of air if under tension)
	  • Leave IV catheter in place while awaiting chest tube
	• **Have appropriate personnel place chest tube**

Advanced Checks	• Fiberoptic bronchoscopy to evaluate for endobronchial intubation, ET tube obstruction • Lung ultrasound: Lung sliding (normal) vs. lung point (pneumothorax) seashore sign (normal) vs. barcode (pneumothorax) • Consider STAT portable chest x-ray; do not delay treatment
Disposition	• Consider ICU care for respiratory monitoring and chest tube management

END

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Power Failure

Sudden darkness
Loss of electrically powered equipment

TREATMENT

Task	Actions
Crisis Resources	• Inform team • Call for help
Obtain Light Source	• **Use any available light sources:** laryngoscope, cell phone, flashlight, ambient light from opening door or shades

Confirm Ventilator	• Ventilator may have temporary (~30 minute) battery. Consider utilizing transport ventilator
	• **If ventilator is not working:**
	  • Consider converting to spontaneous ventilation
	  • Ventilate with self-inflating bag (Ambu)
	  • Convert to TIVA with battery operated pump or dial-a-flow / manual flow regulator

Confirm Monitor	• **If monitors fail:**
	  • Assign person for continuous pulse check
	  • Perform manual blood pressure measurement
	  • Use transport monitor or defibrillator monitor

Confirm Backup O_2	• If power failure affects oxygen supply or alarms: **See Oxygen Failure #21**
Confirm Backup Power	• Ensure generator-supplied emergency power outlets are functional • Connect all life-sustaining equipment to emergency outlets • Disconnect non-life-sustaining equipment from emergency outlets

Report Problem	• Inform Charge Nurse, Anesthesia Lead, and all ORs
	• Call bio-engineering to:
	  • Report problem; ask for help with diagnostics and repair while you focus on patient care: if only in your OR, suggest checking if circuit breaker was tripped
	  • Find out if issue is system wide

Team Recap	• Discuss with surgeon and team the implications of power failure for this patient and OR schedule

END

Right Heart Failure

Dyspnea, dizziness, edema, right upper abdominal discomfort
Hypotension
ECG with RV strain
TEE / TTE with dilated RV, reduced RV function
Flattening of interventricular septum
Decompensation after hypoxemia, hypercarbia, or acidosis
Decompensation upon initiation of mechanical ventilation

TREATMENT

Task	Actions
Crisis Resources	• Inform team • **Call for a pulmonary vasodilator such as nitric oxide (e.g. INOmax) or epoprostenol (e.g. Flolan, Veletri)** • Call for code cart and **TEE / TTE** • Call for Cardiac Anesthesiology, Cardiology, or ICU help
Airway	• **100% O_2 10 - 15 L/min** • Decrease tidal volume and increase respiratory rate to **lower intrathoracic pressure** and **avoid hypercarbia.** Avoid breath stacking • **Minimize PEEP** if tolerated; **avoid hypoxemia**

ECHO	• Assess key TEE / TTE findings:
	  • Decreased RV function: Tricuspid Annular Plane Systolic Excursion (TAPSE): severely reduced < 6mm; normal 16-20 mm
	  • RV volume/pressure overload: Flattened interventricular septum makes left ventricle appear D-shaped
	  • RV dilation and/or hypertrophy
	  • Underfilled LV despite adequate preload

RULE OUT

Consider Life-Threatening Causes of RV Failure

- Cardiac tamponade: perform emergent pericardiocentesis
- Protamine: stop administration
- Embolism: e.g. air, clot, fat
  See Embolism #9
- RV infarction
  See Myocardial Ischemia #20
- Tension pneumothorax
  See Pneumothorax #22

GO TO NEXT PAGE »

Right Heart Failure

TREATMENT

Task	Actions
ECMO/CPB	• If significant instability: consider ECMO or cardiopulmonary bypass

Decrease RV Afterload	• Offload RV by decreasing pulmonary vascular resistance (PVR):
	  • Give inhaled **prostacyclin** derivatives, inhaled **nitric oxide,** or intravenous pulmonary vasodilators
	  • **Avoid hypoxemia, hypercarbia, acidosis, or excessive intrathoracic pressure**

Maintain RV Contractility	• Avoid hypotension to maintain myocardial perfusion
	  • If decreased RV contractility: consider **epinephrine**
	  • If normal RV contractility: consider **vasopressin** or **norepinephrine**
	  See Infusion List #29
	  • If refractory hypotension: consider intra-aortic balloon pump (IABP) to maintain coronary perfusion

Maintain Normal RV Volume Status	• **RV overload is more dangerous than mild hypovolemia** • RV overload suggested by CVP > 20mmHg and/or SvO_2 < 65% • If RV overload: **consider diuresis** and seek expert advice • If RV under-filled: careful volume replacement with blood or crystalloid per HCT

Maintain Normal Sinus Rhythm	• Avoid bradycardia or extreme tachycardia to maintain cardiac output
	• Identify and treat electrolyte abnormalities
	• Maintain atrial kick to augment cardiac output
	  • If irregular rhythm:
	  See SVT #3

END

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Transfusion Reaction

Hemolytic Reaction:	Febrile Reaction:	Anaphylactic Reaction:
Fever	**Fever**	**Hypotension**
Back/flank pain	**Chills**	**Urticaria**
Tachycardia	**Rigors**	**Other rash**
Tachypnea	**Headache**	**Wheezing**
Hypotension	**Vomiting**	**Tachycardia**
Dark urine		
Oozing or DIC		

TREATMENT

Task	Actions
Stop Transfusion	• **Stop transfusion(s)** • Retain blood product bag(s)
Crisis Resources	• Inform team • Identify leader • Call for help • Call for code cart • Consider pausing procedure
Airway	• **100% O_2 10 - 15 L/min** • If no ET tube in place: consider intubation

Circulation	• Consider IV fluid bolus
	• If hypotensive:
	  • **Turn anesthetic down or off**
	  • Treat with vasopressor bolus (e.g. phenylephrine, ephedrine)
	  • If severe: give **epinephrine** 10 - 100 mcg IV and/or vasopressin 0.5 - 1 units IV

Blood Bank	• Send appropriate labs and return units per local protocol
Specific Reaction Treatments	• **Hemolytic Reaction**: monitor for signs of **DIC**; maintain urine output with IV fluids, diuretics • **Febrile Reaction**: treat with **antipyretic acetaminophen 1000 mg IV**; rule out hemolysis; rule out bacterial contamination • **Anaphylactic Reaction**: give **epinephrine bolus and then infusion**. Consider steroid: dexamethasone 4 - 8 mg IV or hydrocortisone 100 mg and antihistamine: diphenhydramine 25 - 50 mg IV and famotidine 20 mg IV **See Anaphylaxis #5**
Disposition	• May require ICU care

END

Trauma

Blunt force or penetrating injury to major organs

TREATMENT - TRAUMA BAY

Task	Actions
Crisis Resources	• Call trauma code • Activate trauma operating room • Activate massive transfusion protocol (MTP)
On Arrival to Trauma Bay	• All team members state name and role. Use clear, closed-loop communication; record events • Check pulse. **If no pulse: start ACLS while transfusing and performing primary survey to find and treat cause** • Place standard monitors and obtain large-bore IV access • Maintain **c-spine precautions** with all movement

Primary Survey	• **Airway and Breathing:**
	  • Evaluate airway, ensure oxygenation and ventilation
	  • Intubate in indicated. Recommend RSI with video laryngoscopy, in-line stabilization, and capnography. **If hypotensive: modify or eliminate induction medication**. If indicated, surgical airway
	  • Treat pneumo or hemothorax with emergent chest tubes
	• **Circulation:**
	  • Control external hemorrhage. Transfusion preferred over crystalloid bolus. Do **FAST:** Focused Assessment with Sonography for Trauma
	• **Disability:**
	  • Assess level of consciousness, pupils, glucose, and Glasgow Coma Scale (GCS), on right
	• **Exposure:**
	  • Fully expose to assess injury then cover to prevent hypothermia

Secondary Survey	• **AMPLE History:** Allergies, Meds, Past medical history, Last meal, Events leading to injury • **AT MIST:** Age, Time of injury, Mechanism of injury, Injuries sustained, Systemic review, Treatments • Head-to-toe physical exam and radiologic evaluation

GCS
Eye opening:
4 - Spontaneous
3 - To speech
2 - To pain
1 - None
Verbal response:
5 - Oriented
4 - Confused
3 - Inappropriate words
2 - Sounds
1 - None
Motor response:
6 - Obeys
5 - Localizes to pain
4 - Flexion to pain
3 - Abnormal flexion
2 - Abnormal extension
1 - None

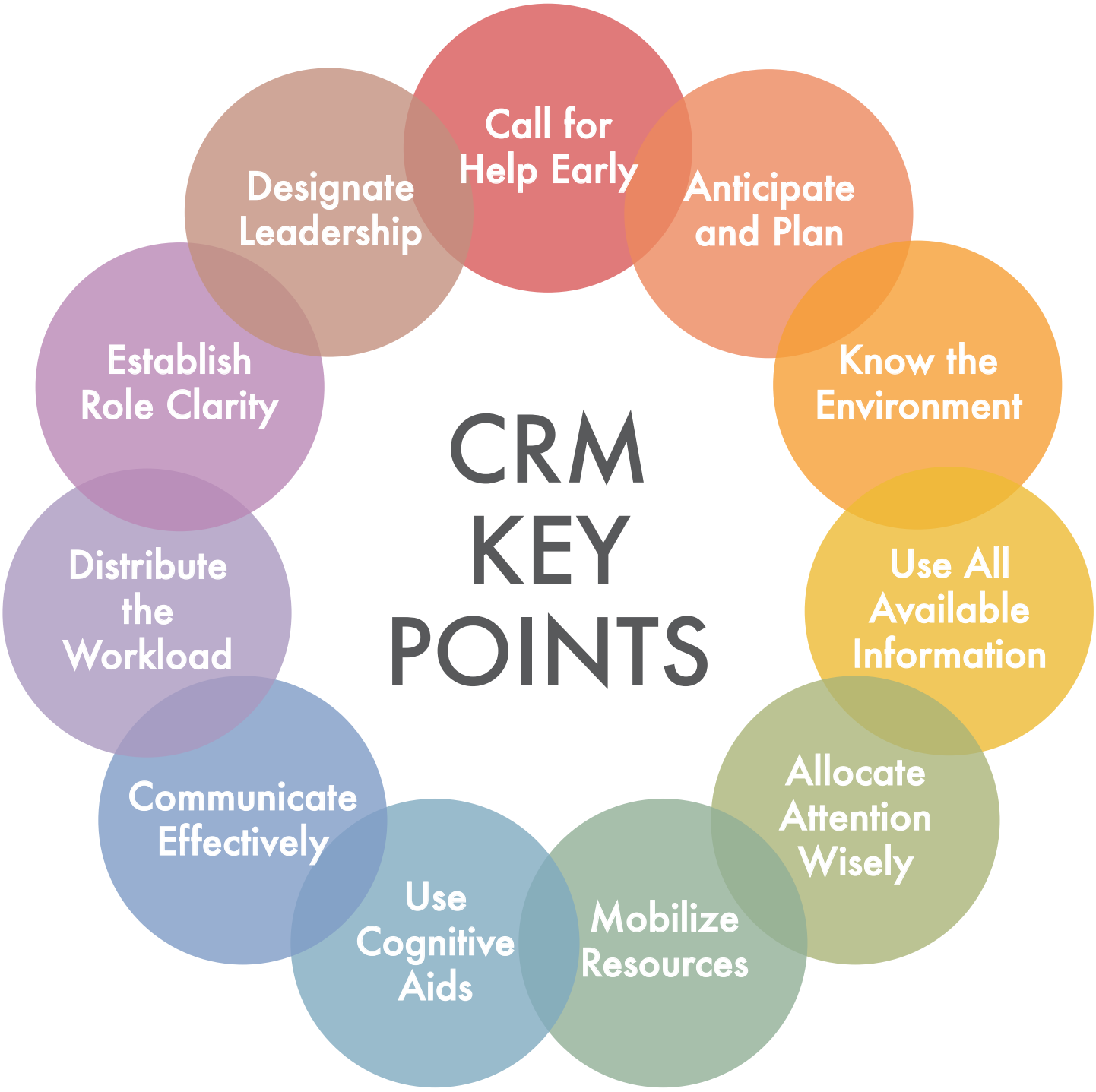
GO TO NEXT PAGE »

TREATMENT - TRAUMA OR

Task	Actions
Trauma OR Setup **(Prep in advance and check before patient arrival)**	• **Warm OR** to > 25° C (77° F) to maintain normothermia • **Setup:** machine, suction, monitors, airway (video laryngoscope and surgical airway), IV and IO kits, rapid infusion device, ultrasound machine, code cart, invasive monitoring equipment (e.g. arterial line, CVP), cell saver • **Meds:** e.g. midazolam, ketamine, propofol, etomidate, scopolamine, succinylcholine, rocuronium, epinephrine, vasopressin, ephedrine, phenylephrine, calcium, antibiotics • **Check:** crystalloid, colloid, and **blood products (MTP)**
Induction and Airway	• Place standard ASA monitors and preoxygenate • If patient conscious: briefly reassure them • Discuss among team (e.g. Anesthesiology, Surgery, Nursing, others) timing and order of priorities including IV and arterial access, inducing anesthesia, securing airway, hemorrhage resuscitation, and incision • Perform RSI with c-spine precautions • Place additional IVs and arterial line • If stable: anesthetic maintenance with volatile anesthetic. If unstable, maintenance with benzodiazepine or ketamine
Temporize	• **If severe instability: inform surgeon;** discuss temporizing measures (e.g. packing, aortic compression, aortic crossclamp, thrombin, fibrin glue, REBOA)
Transfuse	• Based on clinical picture: transfuse with ratio of **1-2 PRBC : 1 FFP : 1 Platelet pack** • Coagulopathy may require cryo, fibrinogen, calcium, TXA
Traumatic Brain Injury	• **Maintain CPP while decreasing ICP:** MAP ≥ 80, SBP ≥ 100 mmHg, SpO_2 ≥ 90%, $EtCO_2$ 35 - 40 mmHg, mannitol or hypertonic saline, head up position, and burst suppression
Labs	• Crossmatch, serial ABG, lytes, lactate, coags
Meds	• **If < 3 hours since injury give tranexamic acid (TXA):** 1g IV over 10 min, then 1g every 8 hrs • Give calcium for coagulation and blood pressure • Treat hyperkalemia: calcium chloride 1 g IV; sodium bicarbonate 1 amp IV (50 mEq); regular insulin 5 - 10 units IV with dextrose/D50 1 amp IV (25 g)
Post Event	• ICU care for continued resuscitation

END

CRISIS RESOURCE MANAGEMENT



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CRISIS RESOURCE MANAGEMENT

Call for Help Early

- Call for help early enough to make a difference
- Err on the side of getting more help
- Mobilize early personnel with special skills if they may be needed

Designate Leadership

- Establish clear leadership
- Inform team members who is in charge
- 'Followers' should be active in asking who is leading

Establish Role Clarity

- Determine who will do what
- Assign areas of responsibility appropriate to knowledge, skills, and training
- Active followers may offer specific roles

Distribute the Workload

- Assign specific tasks to team members according to their abilities
- Revise the distribution if there is task overload or failure

Communicate Effectively

- Command and request clearly
- Seek confirmation of request (close the loop)
- Avoid "thin air" statements
- Foster input and atmosphere of open information exchange among all personnel

Anticipate and Plan

- Plan & prepare for high work-load periods during low work-load periods
- Know where you are likely headed during the crisis and make backup plans early

Know the Environment

- Maintain situational awareness
- Know how things work and where things are
- Be aware of strengths and vulnerabilities of environment

Use All Available Information

- Monitor multiple streams of data and information
- Check and cross check information

Allocate Attention Wisely

- Eliminate or reduce distractions
- Monitor for task saturation & data overload
- Avoid getting fixated
- Recruit others to help w/ monitoring

Mobilize Resources

- Activate all helpful resources including equipment and additional personnel

Use Cognitive Aids

- Be familiar with content, format, and location
- Support the effective use of cognitive aids

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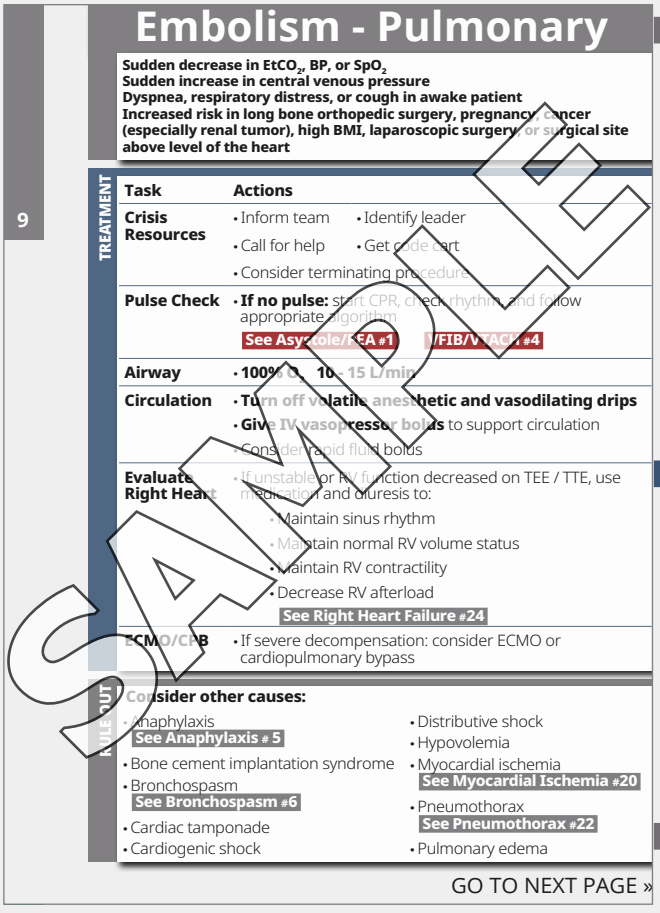
Emergency Manual V4 - Design Overview

- ACLS events in red and listed first
- Combined event for Unstable and Stable SVT

- Other events in gray and listed alphabetically for easy access
- Content updated for all events after in-depth literature review
- New events: Hypertension, High Airway Pressure, Right Heart Failure, Trauma
- Combined event for multiple Embolism etiologies

- Important resources in teal: Crisis Resource Management (CRM), Cognitive Aid Information, and Infusion List


9
Embolism - Pulmonary
Sudden decrease in EtCO2, BP, or SpO2
Sudden increase in central venous pressure
Dyspnea, respiratory distress, or cough in awake patient
Increased risk in long bone orthopedic surgery, pregnancy, cancer (especially renal tumor), high BMI, laparoscopic surgery, or surgical site above level of the heart
TREATMENT
Task
Actions
Crisis Resources
• Inform team • Identify leader
• Call for help • Get code cart
• Consider terminating procedure
Pulse Check
• If no pulse: start CPR, check rhythm and follow appropriate algorithm
See Asystole/PEA #1
VFIB/VTACH #4
Airway
• 100% O2, 10 - 15 L/min
Circulation
• Turn off volatile anesthetic and vasodilating drips
• Give IV vasopressor bolus to support circulation
• Consider rapid fluid bolus
Evaluate Right Heart
• If unstable or RV function decreased on TEE / TTE, use milrinone and diuresis to:
• Maintain sinus rhythm
• Maintain normal RV volume status
• Maintain RV contractility
• Decrease RV afterload
See Right Heart Failure #24
ECMO/CPB
• If severe decompensation: consider ECMO or cardiopulmonary bypass
Consider other causes:
• Anaphylaxis
See Anaphylaxis # 5
• Bone cement implantation syndrome
• Bronchospasm
See Bronchospasm #6
• Cardiac tamponade
• Cardiogenic shock
• Distributive shock
• Hypovolemia
• Myocardial ischemia
See Myocardial Ischemia #20
• Pneumothorax
See Pneumothorax #22
• Pulmonary edema
GO TO NEXT PAGE »
SAMPLE

- Each event title is followed by potential signs and symptoms so you know if you are on the right track

- Blue "Treatment" boxes list critical tasks and actions in order of importance, starting with Crisis Resource Management (CRM) key points
- Can be used during a crisis, to anticipate and plan, for teaching, and for post-event debriefing
- "Task" categories with "Actions" to be completed in order or sampled for specific information
- "See Event #" highlights help you consider other relevant events

- Gray boxes assist with diagnosis or prevention tips

Emergency Manual V4 - Use and Implementation

Use: Recent research suggests that Emergency Manual (EM) use improves teamwork, facilitates coordination, decreases stress, and enables delivery of better patient care.[1] The Stanford EM, and other similar tools, are used effectively in both clinical and educational settings:

Clinical:

- Pre-event for 'just in time' review for at-risk patients
- During event for crisis management
- Post-event for team debriefing

Educational:

- Self-review
- 1:1 or small group teaching
- Studying for oral exams
- During simulation cases and debrief sessions

We welcome your feedback and continuously learn from our community of users.

Implementation: These websites include a number of tips and free resources to support EM implementation by your interprofessional team:

- Stanford EM - https://emergencymanual.stanford.edu/
  Download the EM in English or another language, find implementation tips, and learn more
- Emergency Manual Implementation Collaborative (EMIC) - https://www.emergencymanuals.org/
- EM Implementation Toolkit - https://www.implementingemergencychecklists.org
  This resource-rich guide, developed with Ariadne Labs, includes videos you can use or adapt, and other training materials.

Stanford EM Formats:

- Large (8 ½ x 11") hanging printed version (most popular), with or without event number tabs*
- Small (4 ¼ x 5 ½") printed pocket version*
- PDF with hyperlinks (accessible on a computer, mobile device, or an electronic health record)
- E-book

*Our printed versions are operating room safe (wipeable, and MRI-safe). You can use any printer you choose. See our website for information about our printer.

EM Customization - See our website for templates to customize for your setting:

- Infusion List (inside back cover)
- Phone List (outside back cover)

EM Training:

- EM Reader: reads aloud to team/leader to interactively ensure vital actions are performed, medication doses correct, diagnoses considered, find specific desired information, while allowing leader to maintain situational awareness and team communication.[2]
- Train team members to ask empowering questions: Would you like me to get/read the emergency manual? Which event in the emergency manual are we dealing with? These can help the leader remember the EM is available and can trigger its use. In our experience, leaders often answer, "Yes," and had forgotten about the EM due to the stress of the crisis.

1. Goldhaber-Fiebert SN, Howard SK, Gaba DM, et al. Clinical Uses and Impacts of Emergency Manuals During Perioperative Crises. Anesth Analg. 2020 Dec;131(6):1815-1826.
2. Burden AR, et al. Does every code need a "reader?" Improvement of rare event management with a cognitive aid "reader" during a simulated emergency: a pilot study. Simul Healthc. 2012 Feb;7(1):1-9.

Emergency Manual V4 - Publication Details

Stanford Anesthesia Cognitive Aid Program (SACAP) EM V4 Team:

Ellile Sultan, MD
Amanda Burden, MD
Barbara K. Burian, PhD
Naola S. Austin, MD
Kyle Harrison, MD
Sara Goldhaber-Fiebert, MD
Steven K. Howard, MD
David M. Gaba, MD

Summer Reid, BA (Administrative Associate)

Acknowledgements: Iterative simulation testing and integration of feedback from clinical uses of V3 were integral to the development of V4. Meredith Hutton MD and Vladimir Nekhendzy MD made author-level contributions to content and usability of the Difficult Airway / Cric event. We appreciate the leadership, faculty, trainees, and staff at Stanford for their support of the development, implementation, and improvement of this emergency manual over the past decade. Many individuals contributed over the years. For this version, we especially appreciate the detailed reviews of content, design, and usability, by 38 global expert physicians from 16 institutions and 8 countries. For more information on current and past contributions, please visit our website: https://emergencymanual.stanford.edu/

References: Citations are not written on each event given usability priorities, but you can visit our website if interested in relevant content literature. We strive to integrate the most pertinent clinical information from published literature and clinical practice guidelines.

Citation: Stanford Anesthesia Cognitive Aid Program,* Emergency Manual: Cognitive aids for perioperative crises, Version 4, 2021. See http://emergencymanual.stanford.edu for latest version.
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*Goldhaber-Fiebert SN, Austin N, Sultan E, Burian BK, Burden A, Howard SK, Gaba DM, Harrison TK.

Local Modifications and Creative Commons Licensing: Research supports that local customization of cognitive aids is helpful for many reasons. We allow all needed modifications for use at your local institution, without further permissions. You should keep original authorship attribution and add 'Adapted By ___.' For more than minor PDF modifications or local phone list for back cover, we suggest requesting our original InDesign file: Email EMadminanes@lists.stanford.edu. We are not responsible for any errors introduced and caution that there are usability cons to adding too much information. See this review for an overview of effective cognitive aid design.[1] No derivatives may be shared beyond local use without explicit permission (e.g. translations or hospital systems that contact us first), and all use must be non-commercial. We use Creative Commons 4.0 International Licensing, With Attribution, Non-Commercial, and No Derivatives; See details at https://creativecommons.org/licenses/by-nc-nd/4.0/

Disclaimers: The material in this Manual is not intended to be a substitute for sound medical knowledge and training. Clinicians should always use their clinical judgment and decision making for patient management. Departure from the information presented here is encouraged as appropriate, since situations can vary widely.

We use generic medication names whenever possible and include some brand names, which might be better known to clinicians, to support effective use during crises. To reduce potentially distracting visual clutter, TM superscripts have not been included with brand name medications in the cognitive aids.

Enabling clinical uses during crises requires systematic implementation efforts beyond simply hanging emergency manuals (EM) in operating rooms, as EMs can be forgotten when under stress. Use the resources on the previous page to efficiently and effectively integrate EMs into your practice.

1. Burian BK, Clebone A, Dismukes K, Ruskin KJ. More Than a Tick Box: Medical Checklist Development, Design, and Use. Anesth Analg. 2018 Jan;126(1):223-232.

Infusion List

Amiodarone
1200 mg in 250 mL D5W
4.8 mg/mL
Load 150 mg over 10min;
300 mg bolus if pulseless
Infuse 1 mg/min (no weight calc)

Clevidipine (Cleviprex™)
25 mg in 50 mL
0.5 mg/mL
Infuse 1-16 mg/hr (no weight calc)

Dexmedetomidine (Precedex™)
400 mcg in 100 mL NS
4 mcg/mL
Load 0.5-1 mcg/kg over 10 min
Infuse 0.2-1.5 mcg/kg/hr

Diltiazem (Cardizem™)
125 mg in 100 mL NS/D5W
1.25 mg/mL
Load 2.5 mg up to 25 mg
Infuse 2-10 mg/hr (no weight calc)

Dobutamine
500 mg in 250 mL D5W
2000 mcg/mL (2 mg/mL)
Infuse 2-20 mcg/kg/min

Dopamine
400 mg in 250 mL D5W
1600 mcg/mL
Infuse 2-10 mcg/kg/min

Epinephrine
4 mg in 250 mL NS
16 mcg/mL
Infuse 0.02-0.3 mcg/kg/min
(20-300 nanograms/kg/min)

Esmolol (Brevibloc™)
2500 mg in 250 mL NS
10 mg/mL
Infuse 0.05-0.3 mg/kg/min
(50-300 mcg/kg/min)

Fenoldopam (Corlopam™)
10 mg in 250 mL NS/D5W
40 mcg/mL
Infuse 0.05-0.20 mcg/kg/min

Isoproterenol (Isuprel™)
1 mg in 250 mL NS/D5W
4 mcg/mL
Infuse 1-5 mcg/min (no weight calc)

Lidocaine (Xylocaine™)
2 g in 250 mL NS
8 mg/mL
Load 1-1.5 mg/kg
Infuse 1-2 mg/kg/hr

Milrinone (Primicor™)
20 mg in 100 mL D5W
200 mcg/mL
Load 50-75 mcg/kg over 10 min
Infuse 0.375-0.75 mcg/kg/min

Nesiritide (BNP)
1.5 mg in 250 mL D5W
6 mcg/mL
Load 2 mcg/kg over 1 min
Infuse 0.01 mcg/kg/min

Nicardipine (Cardene™)
40 mg in 200 mL
0.2 mg/mL
Infuse 5-15 mg/hr (no weight calc)

Nitroglycerin (Tridil™)
50 mg in 250 mL D5W
200 mcg/mL
Infuse 0.1-1 mcg/kg/min

Nitroprusside (Nipride™)
50 mg in 250 mL NS
200 mcg/mL
Infuse 0.1-1 mcg/kg/min

Norepinephrine (Levophed™)
4 mg in 250 mL NS
16 mcg/mL
Infuse 0.02-0.3 mcg/kg/min
(20-300 nanograms/kg/min)

Phenylephrine (Neosynephrine™)
40 mg in 250 mL NS
160 mcg/mL
Infuse 0.1-1 mcg/kg/min
(or 5-100 mcg/min)

Remifentanil (Ultiva™)
2000 mcg (2 mg) in 40 mL NS
50 mcg/mL
Infuse 0.01-0.2 mcg/kg/min

Vasopressin
60 units in 100 mL NS
0.6 units/mL
Infuse 0.01-0.1 units/min (no weight calc)

EMERGENCY MANUAL

Phone List
Placeholder